

APPENDIX E

Philadelphia Area Reasonable Further Progress (RFP) Demonstration

Technical Support Document *Mobile Source Highway Emissions Inventory*

Executive Summary

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Philadelphia Area: Reasonable Further Progress Demonstration
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Summary of Appendices

- Appendix E-1:** Mobile Source Highway Emissions Inventory – An Explanation of Methodology
- Appendix E-2:** Philadelphia Area (VOC, NO_x) Emission Results
- Appendix E-3:** MOBILE6.2 Input Parameter Summary
- Appendix E-4:** MOBILE6.2 Sample Input Files
- Appendix E-5:** Traffic Growth Forecasting System Report

INTRODUCTION

This technical document supports the requirement for the Philadelphia 5-county region, as a moderate eight-hour ozone nonattainment area, to demonstrate Reasonable Further Progress (RFP) towards attainment by 2008. EPA regulations and guidance define RFP as demonstrating a 15 percent (VOC and/or NOx) emissions reduction from 2002 to 2008. The Philadelphia Area is required to demonstrate that the remainder of the emission reductions needed for attainment will be achieved by the attainment date. This document provides the base year and future year projections of mobile (highway) vehicle miles of travel (VMT) and emissions (ozone precursors VOC and NOx) that are needed for the RFP demonstration.

Methodology

Guidance documents from EPA were used to develop the emissions inventories for the Philadelphia Area. They include:

- *Policy Guidance on the Use of MOBILE6 for SIP Development and Transportation Conformity*, US EPA Office of Air and Radiation, dated January 18, 2002.
- *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation*, US EPA Office of Transportation and Air Quality, EPA420-R-04-013, dated August 2004.
- *User's Guide to MOBILE 6.1 and MOBILE6.2, Mobile Source Emission Factor Model*, EPA Office of Air and Radiation, EPA420-R-03-010, dated August 2003.

Mobile source emission factors were calculated using EPA's MOBILE6.2 emission model. The methodologies used to produce the emission results conform to the recommendations provided in EPA's Technical Guidance. A mix of local data and national default (internal to MOBILE6.2) data has been used for this submission. Local data has been used for the primary data items that have a significant impact on emissions. These include:

- VMT and speeds
- Vehicle type mixes
- Vehicle age distributions
- Seasonal adjustments
- Hourly distributions
- Temperatures/humidity/barometric pressure
- Inspection/Maintenance parameters
- Fuel program characteristics.

For this submission, the 2002 base year emission estimates are consistent with past analyses and submissions utilizing 2002 traffic and environmental data. Future year estimates for 2008 and 2009 are based on the latest available 2005 traffic data, growth rates, and environmental parameters. The analysis methodology is consistent with past statewide inventory efforts including the 2002 National Emissions Inventory (NEI) submission. A detailed methodology is provided in **Appendix E-1**.

The following sections address the key input data sources and analysis tools used for the Philadelphia Area inventory. The final section summarizes the inventory emission results for all applicable ozone pollutants.

Inventory Submission Materials

To complement this document, attachments have been provided with additional detail regarding the analysis methodology, the MOBILE6.2 input parameters, and the output VMT and emission results for the Philadelphia Area. These include:

Table 1: Summary of Appendices

Appendix	Title	Description
E-1	Mobile Source Highway Emissions Inventory – An Explanation of Methodology	Provides summary of methodology used to calculate the VMT and emissions.
E-2	Philadelphia Area (VOC, NOx) Emission Results (By Year, Functional Class and Vehicle Type)	Provides county-by-functional class emission tables and county-by-vehicle type emission tables for a <i>summer weekday</i> in 2002, 2008 and 2009
E-3	MOBILE6.2 Input Parameter Summary	Provides summary of input parameters related to traffic data sources, fuel, weather, I/M, and other MOBILE6.2 related parameters.
E-4	MOBILE6.2 Sample Input File	Provides examples of the MOBILE6.2 input files.
E-5	Traffic Growth Forecasting System Report	Details the growth forecasting methodology used to estimate future emissions.

DATA SOURCES AND ANALYSIS TOOLS

This section provides a summary of the key input data and analysis tools used for producing the Philadelphia Area emissions inventory used for the RFP demonstration. The key elements to the modeling protocol are described in the sections below. A more detailed description of the analysis process and tools is provided in the methodology report in **Appendix E-1**.

Analysis Tools

The Philadelphia Area inventory analysis utilizes several key software/programs for producing the county emissions totals. These tools are outlined in **Table 2**.

Table 2: Summary of Inventory Analysis Tools

Tool	Purpose
MOBILE6.2	Produces emission factors for each pollutant in Grams/Mile for VOC and NOx
PPSUITE	Processes the highway data, Calculates hourly congested speeds for each state roadway segment, Prepares MOBILE6.2 input files, Processes MOBILE6.2 output files
Custom SCC Output Reformatting Program	Prepares output database files by EPA's Source Classification Codes (SCC)

The Philadelphia Area inventory reflects the highway mobile source emission estimations using EPA's MOBILE6.2 emission model. The latest version of MOBILE is a major revision based on new test data and accounts for changes in vehicle technology and regulations. In addition, the model includes an improved understanding of in-use emission levels and the factors that influence them resulting in significantly more detailed input data. As compared to previous MOBILE versions, MOBILE6.2 has a significant impact on the emission factors, benefits of available control strategies, effects of new regulations, and corrections to basic emission rates.

PPSUITE represents an enhanced version of the Post Processor for Air Quality (PPAQ) software system that has been used for previous inventory and conformity submissions in Pennsylvania. The software has undergone significant revisions to ensure consistency with the MOBILE6.2 emissions model. PPSUITE plays a key role in the development of hourly roadway speed estimates, which are supplied as input to the MOBILE6.2 model. The software is also used to prepare the MOBILE6.2 input shell and to process the MOBILE6.2 outputs.

Custom programs have also been prepared to translate the VMT and emission results into a database file indexed by EPA's Source Classification Code (SCC). This code represents combinations of vehicle type groupings, functional classes, and time periods.

Traffic Data Source/Fleet Data Inputs

The PennDOT Roadway Management System (RMS) data serves as the primary highway data source for the county and functional class VMT estimates. The data source has been updated to provide a “snapshot” of the regional roadway system and volumes in 2002 and 2005. The data includes the average annual daily traffic volumes for all state roadways within Pennsylvania. To account for additional local roadway VMT and to ensure consistency with reported HPMS totals, the 2002 and 2005 VMT totals are adjusted to match the HPMS VMT totals reported to FHWA.

Based on the requirements for ozone inventories, traffic volumes on each RMS roadway segment must be adjusted to a summer weekday. The daily and monthly seasonal factors used for future year analysis runs are developed from data contained in the document, *2005 Pennsylvania Traffic Data*, as prepared by PennDOT’s Bureau of Planning and Research. The seasonal and daily factors provided in the document are based on statistical analyses of traffic counts taken at permanent and in-pavement ATR (automatic traffic recorder) locations throughout the state. Based on these seasonal traffic volumes, the PPSUITE software calculates unique congested speeds for each roadway segment during an ozone summer weekday scenario.

PPSUITE calculates congested speeds by hour of the day for each roadway segment and provides the information as input to the MOBILE6.2 software. To disaggregate the daily RMS volumes to hourly volumes, auto and truck hourly pattern data from PennDOT’s *2005 Pennsylvania Traffic Data* report are used to determine the temporal variations of future year traffic volumes.

Vehicle mix patterns are calculated for each county / functional class grouping utilizing a combination of 2002/2005 RMS truck percentages and MOBILE6.2 default vehicle mix distributions. The development of vehicle type pattern data input to the MOBILE6.2 software is described in more detail in **Appendix E-1**. The distribution of vehicles to fuel type (diesel, gas) is determined from the MOBILE6.2 default diesel sales fractions.

Vehicle age distributions are input to MOBILE6.2 for each county based on registered vehicles that reflect July 1 summer conditions. These distributions reflect the percentage of vehicles in the fleet up to 25 years old and are listed by the 16 composite MOBILE6 vehicle types. 2002 and 2005 vehicle age distributions have been used for this inventory from the PennDOT Bureau of Motor Vehicles Registration Database. Due to insufficient data, only data for light-duty vehicles are used as local inputs. The heavy-duty vehicles use the internal MOBILE6.2 defaults.

Traffic Growth Assumptions

Traffic growth forecasting plays a pivotal role in estimating future year emissions for the region. The Department recognizes, though, that VMT forecasting is a difficult and sometimes imprecise process in which various techniques and inputs may result in different estimates. As a result, the VMT forecasts included for this inventory utilize county-specific growth rates from a PennDOT study completed in 2005 and travel demand modeling results provided by DVRPC in June of 2007.

As part of the PennDOT study, a statewide traffic growth forecasting system was developed that incorporates traffic data from PennDOT’s Traffic Information System and socioeconomic forecasts. The study data and statistical models were recently updated with 2006 socioeconomic forecasts and the latest available HPMS VMT trends.

The study and methodology are documented in the report “*Statistical Evaluation of Projected Traffic Growth, Traffic Growth Forecasting System: Final Report, March 14, 2005*” and contains the following improvements over past non-model based approaches:

- Strong statistical basis and consistent with state of the art.
- Thorough documentation of approach vs. alternatives.
- Increased robustness through the inclusion of both county-level historical traffic trends from the RMS databases and county-based demographic projections from an independent 3rd party (Woods and Poole Economics, Inc.).
- Incorporates socio and economic data (households, mean household income) and a relative measure of transportation capacity (lane miles per capita).
- Expedient and inexpensive update process.

The results of the study have been shared between PennDOT, PaDEP, and other Interagency Consultation Group members, including the PA Conformity Work Group (which includes EPA, FHWA, and representatives from larger MPOs within the state).

The resulting forecasting system includes the development of VMT forecasts and growth rates for four functional classifications in each Pennsylvania county: urban interstate, urban non-interstate, rural interstate, and rural non-interstate. The forecasts use statistical relationships based on historic HPMS VMT trends and future county socioeconomic projections from Woods and Poole Economics, Inc. The model results from county-based household model are used. This is a statistical model incorporating historical VMT trends, socio and economic data (households, mean household income), and a relative measure of transportation capacity (lane miles per capita).

For this inventory and for the development of transportation conformity budgets, the DVRPC model growth was also used to adjust regional (5-county) VMT and to reflect issues that may not have been captured through the statewide process. The additional travel model growth (over that of the statewide process) was distributed evenly across the five counties. Emissions estimates, using the adjusted county specific VMT estimates, were then generated and used to establish the transportation conformity budget for the Pennsylvania portion of the non-attainment area. **Table 3** summarizes the assumed projected growth of VMT for future analysis years.

Table 3: Philadelphia Area VMT Growth Assumptions

Analysis Year	Total Growth From 2002	Annualized Growth From Previous Analysis Year
Bucks		
2002	----	----
2008	13.5%	2.2%
2009	18.4%	2.6%
Chester		
2002	----	----
2008	12.6%	2.1%
2009	17.2%	2.5%

Delaware		
2002	----	----
2008	11.4%	1.9%
2009	14.5%	2.1%
Montgomery		
2002	----	----
2008	10.9%	1.8%
2009	14.5%	2.1%
Philadelphia		
2002	----	----
2008	7.9%	1.3%
2009	10.0%	1.4%

I/M and Fuel Parameters

The Inspection Maintenance (I/M) program inputs to the MOBILE6.2 model are based on past and current programs within the Philadelphia area. The Pennsylvania inspection and maintenance (I/M) program was upgraded and expanded throughout the state with a phase-in period starting in December 2003 and fully implemented by June 2004. The program test requirements vary by region and include on-board diagnostics (OBD) technology that uses the vehicle's computer for model years 1996 and newer to download potential engine problems that could effect emissions. The program, named PAOBDII, is implemented in the Philadelphia, Pittsburgh, and South Central / Lehigh Valley Regions. The Northern Region receives gas cap and visual inspections and the other 42 counties in the Commonwealth receive a visual inspection. Vehicles subject to the program include 1975 and newer model year gasoline cars and light duty trucks up to 9,000 pounds GVW. New model year vehicles are exempt for the first year. The county of registration determines which inspections are required.

Within the Philadelphia Area, Bucks, Chester, Delaware, Montgomery and Philadelphia counties have an I/M program. The I/M program parameters for Philadelphia area include:

Model Years	Program Parameters
2004 & newer	PAOBDII Gas Cap
1997 & newer	ASM 5015 FINAL
1975 & newer	ATP

The summer weekday RVP and reformulated gasoline values are consistent with values used for past inventory efforts. These assumptions, as well as the I/M program and fuel parameters, are summarized in **Appendix E-3**.

Weather Data

Updated weather information has been obtained from the National Climatic Data Center to calculate the minimum and maximum temperatures and absolute humidity data inputs to the MOBILE6.2 model.

For the month of July, mean daily minimum and maximum temperatures and barometric pressure values were obtained for each of the weather station locations in Pennsylvania. In addition, relative humidity values are obtained for 6-hour intervals (4 intervals during a 24 day period) for an average day in July. Absolute humidity values are then calculated from the relative humidity and barometric pressure for each of the 4 daily intervals using EPA's M6HUMID program. The lowest of these 4 values is determined to be the absolute humidity for that day. Per EPA guidance, the mean daily minimum and maximum temperatures for an average day in July and the lowest of the absolute humidity values are used as the inputs to MOBILE6.2 for the summer scenario analysis runs.

Other weather data required by MOBILE6.2 are assumed as the program defaults. These include the cloud cover, peak sun, and sunrise/sunset options.

Other Inputs

Federal Programs

Federal vehicle emissions control and fuel programs are incorporated into the MOBILE6.2 software. The programs include:

- The Federal Motor Vehicle Control Program (FMVCP) including the National Low Emission Vehicle Program (NLEV) and federal Tier II / Low Sulfur Fuel Program;
- Emissions standards for medium and heavy duty vehicles in 2002, 2004 and 2007;
- Stage II and Onboard Refueling Vapor Recovery (ORVR).

Note: Pennsylvania considers emissions from refueling operations an area source category. While MOBILE6.2 is employed to calculate emissions factors for that source category, refueling emissions are not included in highway vehicle emissions estimations.

State Programs

The MOBILE6.2 software also allows for modeling of permissible state activities that control emissions from highway vehicles.

In 1998, Pennsylvania promulgated the New Motor Vehicle Emissions Control Program. This program created the Pennsylvania Clean Vehicles Program that required new light-duty highway motor vehicles offered for sale within Pennsylvania to be certified by the California Air Resources Board (CARB) under that Board's Low Emitting Vehicle (LEV) program. The Pennsylvania Clean Vehicles Program does not require the California Zero Emitting Vehicle (ZEV) requirement.

As a compliance alternative to the Pennsylvania Clean Vehicles Program, automakers could elect to comply with the National Low Emission Vehicle (NLEV) program. The NLEV program began phase-in starting in model year 1999 and was the compliance option for automakers. The Pennsylvania rules allowed the NLEV compliance option for the duration of Pennsylvania's participation in the NLEV program. The Commonwealth's participation in NLEV was until model year 2006, thus requiring

automakers to comply with the Pennsylvania Clean Vehicles Program (i.e. California LEV requirements...currently the LEV II program) for model years 2006 and beyond. Pennsylvania is in the process of amending the Pennsylvania Clean Vehicles Program to extend the compliance start date to model year 2008. The modeling results assume a 2008 start year for the Pennsylvania Clean Vehicles Program. Benefits from this program are realized in 2008 and beyond.

The methodology employed to estimate the benefits of adopting CA LEV II emissions standards is consistent with the approach provided in the EPA's June 2002 Guidance (*Modeling Alternative NLEV Implementation and Adoption of California Standards in MOBILE6, June 5, 2002*). The approach assumes:

- Tier2 phase-in schedule consistent with MOBILE6.2 defaults
- LEVII phase-in schedule as provided in EPA's June 2002 Guidance
- Assumes PZEV and AT-PZEV vehicles share the same evaporative emissions as LEVII/Tier2 vehicles

Appendix E-4 contains the modified MOBILE6.2 files used to model the above assumptions. They are consistent with the June 2002 EPA guidance.

The federal Tier 2 / Low Sulfur Fuel Program took effect in 2004 and in practicality supplanted the NLEV program for new light-duty vehicles.

RESOURCES

Draft Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, EPA, June, 2003

Consolidated Emissions Reporting, Federal Register, June 10, 2002

2002 Pennsylvania Traffic Data, PennDOT Bureau of Planning and Research, 2002.

User's Guide to MOBILE 6.1 and MOBILE6.2, Mobile Source Emission Factor Model, EPA Office of Air and Radiation, EPA420-R-03-010, dated August 2003.

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Statistical Evaluation of Projected Traffic Growth, Traffic Growth Forecasting System: Final Report, Michael Baker Jr., Inc., March 14, 2005.